





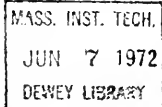


AN INTEGRATED USE OF AVAILABLE RESOURCES  
(STUDENT, PROFESSOR AND TECHNOLOGY)  
IN THE LEARNING PROCESS

John F. Rockart

601-72



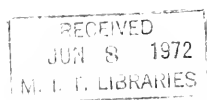


AN INTEGRATED USE OF AVAILABLE RESOURCES  
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### Abstract

The educational literature has recorded many individual advances in technique over the past few years. Self-study courses have been developed. Programmed instruction has been used. Interactive computer programs have been developed. Professors have learned to change dry lecture techniques to more stimulating class discussion. However, in most cases, these advances have been applied one at a time.

The course design discussed here sprang from the understanding that the diverse learning objectives which underlie a well rounded and well structured course lead to the utilization of many classes of learning material. These in turn demand diverse learning methods to be utilized - with each type of material being matched by its most effective learning method and "delivered" by its most efficient resource - professor, student or technology. The implementation of this concept is reported in this paper.

The result was an integrated use of the available learning methods and resources - synergistically utilizing the best of each resource in the learning process. Measurable increases in student performance on examinations, course quality (as expressed by students), and academic productivity all resulted.





It is no secret that the cost of education has risen much faster in recent years than the cost of living as a whole. At the same time, quality appears to have fallen off - or at least perceived quality has been reduced. Students complain about the size of classes, the dedication of the faculty to research rather than teaching, the dullness of some classes, and many other things.

All of these symptoms (despite the recent dropoff in student strikes and other dramatics) may be indicative of what some have termed an "educational crisis". At the very least, they are symptoms of a productivity problem in a labor-intensive industry. While technology has done much to raise output per man in many other industries, it has done little, if anything, in education. A lack of increased productivity not only causes increased costs, it also eliminates the possibility of increasing quality at equivalent cost. Under these conditions, resources are most often strained to merely "keep the system going."

It is clear that the productivity problem in education and other knowledge-based industries now is of extreme importance. As Drucker has pointed out, "The bulk of tomorrow's employment will be in service trades, knowledge jobs - in health care, teaching, government . . . and the like. And no one knows much about knowledge work, let alone how to improve it." [1]

Drucker may overstate the case somewhat. This perceived need has certainly called forth a spate of research. In the education area alone (with which we are concerned in this paper), there has been a significant amount of research into new teaching methods. These have ranged from the development of paper programmed instruction textbooks,\* to computer assisted instruction [3,4], to computer-assisted homework [5], to computer managed instruction, to on-line modeling of significant decision processes [6].

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\*See, for example, [2].



Other efforts have turned their back on the utilization of new technology and instead focused on the behavioral aspects of the learning process. Chief among these has been self-paced self-study learning, one of whose chief and earliest advocates was Keller. Working from Skinnerian principles, Keller in 1965 ran a successful application of self-study [7]. Since then, self-study has grown and flourished although in universities almost entirely on the undergraduate level.\*

In addition to these two major trends - computer assistance and self-study - a host of other efforts have taken place. These include the use of video tape, pass-fail courses, smaller classes, larger classes, student teaching and so forth.

All of the above are efforts to satisfy a felt set of needs which might be enumerated as follows:

1. To increase productivity in the educational process,
2. To achieve "higher quality" of learning (although the definition of quality is unclear),
3. To "take the heat off the student" by allowing him to learn material at his own pace,
4. To individualize instruction to the needs of the particular student, and
5. To provide the student with more autonomy by allowing him to study in depth those subjects which are of great interest to him while achieving an unpenalized minimum standard only in other courses.

One major failing of these efforts has been the lack of good controlled studies to determine what has been accomplished. In the main, most courses involving new techniques such as self-study have been composed of student volunteers willing to take the educational risks of experimental situations. In

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\*See, for example [8,9].



addition, many of the new courses are based on techniques which explicitly do not allow comparisons with control groups. Yet there is an evident need to evaluate new forms of education.

Perhaps most interestingly, most educational innovations have focused on the use of a single technique at a time as a particular instructor has become enamored with CAI, self-paced study, or some other individual method [8,9]. This has been perhaps the major failing of the process of innovation in education. Despite much jaw-boning to the contrary, very seldom has a very detailed look been taken at the existing courses in today's curriculums (especially at the graduate level). If this were done, the rudimentary fact would be noted that most courses are composed, and rightly so, of diverse types of material which meet multiple learning objectives. It follows, then, that diverse learning methods should be applied in each course to enable students to best comprehend the diverse material. This paper reports on an experiment in the integration of available methods "delivered" by varying resources to meet the requirements of diverse learning objectives and the resulting diverse materials in a single course.

The objectives - material - methods - resources development process of an experimental course is illustrated in the next major section of this paper. Much has been written about the need for clear course objectives, the decision process with regard to course material, and the pros and cons of different teaching (or learning) techniques. I have tried to avoid repeating all of this methodology here. Rather, these factors are presented in only as much detail as necessary to illustrate the development of the particular course in issue, which in turn is done primarily as an illustration of the major point of this paper. That point is simply that it is necessary to define carefully the role of each



major resource (professor, student, and technology) so that it is compatible with the prior choices of course objectives, type of material, and learning methods. The choice of the most effective and efficient resource to be utilized in each part of the learning process, it is suggested, can lead to both greater productivity and increased quality in education. The second major section of the paper presents the resulting course design and the final section reviews the results obtained with regard to this course design in a controlled experiment.

### I. A Framework For Course Development

#### Objectives of the Course

The course with which we experimented was a course entitled "Information and Decision Systems I" taught to both undergraduate and graduate students at the Sloan School of Management at MIT. The subject is a core course in both curriculums. It is intended to provide students with an in-depth grounding in the principles and application of accounting for management decision-making purposes. It introduces financial and cost accounting systems as one major segment of corporate information systems.

The course has several objectives. It is felt that the student should learn:

1. The principles which underly the development and use of accounting data.
2. The process of management decision-making in which accounting data is used.
3. The concepts underlying "management planning and control" - the other area of major use of accounting data.
4. The detailed knowledge necessary to actually perform journalizing, adjusting and closing entries, to the corporate books.
5. The process of cost distribution, product pricing, performance analysis, and capital budgetting.





6. The basic concepts concerning data collection and the "fit" of the accounting system with a model corporate information system, and
7. The subjectivity and imprecision inherent in much of the cost and financial data used by management.

#### Pedagogic groupings of course material

With regard to the learning process, the course objectives were operationally translated into teaching material which divided fairly clearly into the following six Pedagogic subsets:

(a) Material illustrating the management process - especially the decision making process. The target course is the initial "functional" course in management for most of the Master's candidates. (Most of the other courses taken in the first term are disciplinary courses.) Some idea of the management process must be depicted. Emphasis is placed on the primary role of decision making.

(b) Motivating material. Accounting methodologies, no matter how important, can be dull. There is a need to insert material which illustrates the absolute need for managers to understand cost and other financial data.

(c) Material concerned with the "language", "principles" and "procedures" of accounting. Making up the bulk of the course, this material is well described, although in highly varying ways, by diverse authors.\* Although far from "cut and dried," this material is clearly set forth in understandable form. It varies in content or form only slightly from year to year.

(d) Material on which the student can test his detailed knowledge and understanding of accounting techniques. This is "practice" material, best popularly exemplified by "homework."

(e) Material highlighting "grey areas" or "major issues" which face the developers and users of financial information. The language and procedures of

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\*Since we wished to illustrate varying views, as well as taking the best from each author, we utilized [12, 13 and 14] in different parts of the course.



accounting leave a great deal of latitude to the individual company accountant in the development of financial results for any period and in the development of cost data. While it is important that the student understand the basic postulates and principles underlying accounting and the results they produce, it is perhaps more important that he understand the "failings" of these man-made principles. It is important for a deeper knowledge of the material for the student to ponder such notions as replacement-cost depreciation, the results in product costing of various methods of overhead distribution, and the effect on the balance sheet of current accounting rules in times of inflation.

(f) Material which is "timely", has changed during the period of the course, or which offers new perspectives on the process. In general, this is material which cannot be (or has not been) put into writing prior to the start of the course. It is material, however, which often adds greatly to student understanding of the course, or which makes the course material "live" through relating it to current events or to ideas which the professor has recently developed and is excited about.

#### Available learning methods

The material above is diverse. It therefore demands diverse treatments. At the very least it demands a careful matching of the way that each type of material can best be assimilated against the repertoire of teaching techniques available. If the learning process were better understood, instead of being a coin-flipping process for the theory which one wishes to select, an unambiguous material-to-technique matching process could take place. Unfortunately, it is not that simple. Today each professor must employ his own heuristics to select techniques for each type of material to be learned.



A learning method may be defined as a procedure, process, or technique by which material is presented to a student with the expectation that the student will gain in the knowledge, understanding or skill encompassed by the material. Many learning methods are available. Use was made in the new course of eleven of the most ubiquitous methods. These eleven learning methods - and some of their cardinal attributes from our point of view - are as follows:

(1) Listening to lectures: excellent for communicating new or ill-defined material. Very poor for the transmission of well-understood facts.

(2),(3) Case discussion or class discussion of readings: excellent for the involvement which they provide, the requirement which they place on the student to "think through" the material - no matter how cloudy the issue - and the need this method poses for the student to determine his own position, and to defend it. Good for the absorption of all sides of major issues and for the exposition of all sides of "grey areas". Poor for learning "facts."

(4) Reading of textbooks: Excellent for the transmission of facts and well-understood, well-digested material.

(5) Reading of programmed instruction (paper): A first-rate alternative for some students to traditional textbooks for the transmission of facts.

(6) Following instructional modules: As developed for self-study courses, modules are "instructor's guides" to sets of materials. When well-written, they provide directions as to how to go about the efficient assimilation of material provided by others of the above learning methods.

(7), (8) Performing homework and taking marked (but ungraded) quizzes: These can allow the student to test his knowledge of each segment of the work and get feedback on his degree of knowledge.



(9) Taking part in "question sessions": (These are class sessions in which the professor or a teaching assistant may be present but which are designed to be "run" by the students who introduce the topics for discussion. Only those topics, which meet the needs of the students at the time, are discussed. The agenda is the student's . . . not the professor's.) Excellent process for original learning or reinforcement of knowledge for some students (see later discussion).

(10) Computer-assisted learning: Very poor, to date, as a replacement for textbooks or paper programmed instruction for original learning of most material on a cost-benefit basis. Highly worthwhile, if the programs are well-developed, in allowing students to test their understanding of material or explore the effects of certain choices in a simulated world represented by a computer model.

(11) Self-paced, self-study: A "meta-method" - incorporating many of the above techniques - which is excellent for the transmission of facts and techniques which are well understood and where the material or adequate guidelines to its comprehension can be adequately presented in written form. Self-study suffers, however, in areas where many views must be heard to illustrate the multiple facets of an important issue. Self-pacing may also be mistaken in a professional school where students must learn to "meet deadlines" as training for later life.

As previously noted, there are additional learning methods not discussed just above. And we have only begun to scratch the surface in developing the multiple attributes of some of these methods. The prime point, however, is that diverse learning methods do have diverse strengths and weaknesses. These attributes of each method must be matched against the attributes of each type of material to be presented within each particular course. To expect that one





learning technique can be stretched to cover all types of material is to deny students the benefits of the application of the correct tool at the correct time. It is similar to a dentist who uses a single cutting bit, or a golfer playing with only his five iron. The task can be accomplished, but with far less than optimal results - both in terms of output and aesthetics.

#### From methods to resources

Interestingly, the eleven teaching methods just presented can be broken down into three major classes along the lines of the three major resources available today to the learning process. The methods fall into classes of those that are professor dominated, those that are heavily dependent on the student for attainment in the learning process, and those in which technology plays a major part. The initial class, which we term professor-intensive, is characterized by class sessions in which the professor takes the responsibility for delivering the material or shaping the discussion. In student-intensive learning, to the contrary, the professor is either not present at the learning site, or merely acts as a resource for the learning student. In technology-intensive learning the prime actor guiding the process is some form of technology - today usually a computer.

From a resource point of view, a curriculum developer can then selectively utilize the strengths of these three major actors. In sum, one can choose among:

- (a) Professors - whose major comparative advantage is not in sheer "information transfer" but rather in the development of motivation, in the leading of discussions of issues to which there are no "right answers" but whose significance must be comprehended, and in the guiding of the student's learning process through intelligent interaction with students.



- (b) Students - whom it has been shown are capable of "active" learning of well-understood, well-documented material on their own when properly directed and relieved of the need to sit "passively" in class, and
- (c) Technology - which, it is believed, can take the place of previous professor or student-intensive methods where patient "answer checking", exploration of a simulated environment, or simple tutoring assistance is necessary.

## II. Specific Course Design

The traditional method of teaching this course had been 24 classes of 1.5 hours each based on both lecture and class discussion techniques. As a result of the above-described process, the new course structure was developed and can be summarized as shown in Exhibit 1. This exhibit illustrates the matching of the types of material to be presented in the target course (rows) with learning methods (columns) and with major resources (groups of columns). It is a sparse matrix since only the most applicable learning methods (the methods used) are noted for each type of material. Following the resource lines shown in Exhibit 1, the new syllabus was divided into two basic types of pedagogy. These were a classroom-oriented set of lessons (professor-intensive) and self-study set (student and technology intensive) as shown at the top of exhibit 1 and described below.

(1) A classroom oriented set of sessions: To take best advantage of the professorial resource, eight classroom sessions remained "required". These sessions (four at the start of the course, two in the middle and two at the end) were timed and designed to make maximum use of professorial skills. The start-of-the-course sessions were used to motivate the students with regard to the material, to provide examples from the instructors' background of the material's



Exhibit 1

Learning Methods		Classroom-Oriented Sessions			Self-Study Sessions							
		Professor Intensive			Student Intensive				Technology Intensive			
		Lecture	Case Discussion	Class Discussion	Text Books	Programmed Instruction	Instruc- tional Modules	Home- work	Feed- back Quizzes	Question Sessions	Computer Models	
Classes of Material												
(1) Decision-making and managerial pro- cess			X	X								
(2) Motivational			X									
(3) Language, principles and pro- cedures of account- ing					X	X	X					
(4) Material to test understanding of (3)												
(5) "Issues," "grey areas"			X						X	X		X
(6) Timely, changing material		X										



importance to managers, to provide an "overview" of the course, and to develop the decision-making setting in which the material is utilized by managers. Basically, the initial sessions were used to provide the students with a "feel", from a managerial viewpoint, of the material they were about to master. The later classroom sessions were utilized to discuss case situations, providing further perspective on basic material previously learned, as well as linking the material to other areas of management knowledge.

All of these classroom sessions were designed around the instructors' comparative advantage over other learning media. In particular, instructors - as previously noted - have advantages in terms of motivation of material; providing students with insights into "issues" in the course; exposing "grey areas" in the material; and, finally, in making managerial case situations "live" - therefore further explicating and providing depth to the material. Material sets 1, 2, 5 and 6 from Exhibit 1 were therefore taught in this manner.

(2) Self-study oriented sessions: The remaining two-thirds of the scheduled course time was devoted to a self-study mode. Material sets 3 and 4 were included here. As noted below, all of the student-intensive and one form of technology-intensive learning methods were utilized in this section of the course.

It is relevant to note that self-study was utilized - not self-paced self-study. The students were paced by the course examinations. It is felt that in their coming professional world, the students will be paced by externally imposed deadlines which they will have to meet by working on their own. There is good reason to provide them with experience in doing exactly this in the academic setting.

For these sixteen self-study sessions, students were expected to study the basic course material on their own. This self-study was assisted, however, by the following:





(a) Nine written guides to the instructional modules: (averaging approximately ten pages each) which provided information as to the (1) particular concepts to be learned, (2) reading to be done (both required and optional), of particular material in the texts, (3) the instructor's comments concerning the material (which ranged from such things as putting stress on particularly important aspects of the reading to further explanation), and (4) homework to be handed in and/or other exercises to be performed, such as on the computer.

(b) Optional attendance at "Question Sessions": Replacing the 16 class sessions which would ordinarily have been held were 12 "question sessions" at which the instructor was present solely to answer student questions on the assignments and to respond to any other questions concerning management in general which the students wished to discuss. Attendance at these sessions averaged 25% of each class (approximately 10 students per session). Some two-thirds of each session turned out to be concerned with questions on the material. The remaining third varied widely over general management subjects - reflecting particular student interests.

(c) Homework: This was marked by the instructor and by teaching assistants. The teaching assistants also answered student questions during their office hours. TA's are traditionally used in this course.

(d) Feedback examinations: These were brief, informal, marked but non-graded "quizzes" which students could take after completing modules 2, 4, 6 and 8 to allow them to gauge their progress in the course. The exams were immediately marked and could be discussed with the teaching assistant.

(e) An interactive computer program - CLOSE: This on-line computer program allowed the student to review, whenever he wished to do so, the complete material of the first half of the course. Financial Accounting (the major material of the first half) breaks down into a simple posting-adjusting-closing cycle of events.



Using computer graphic capability on a CRT screen, students were able to test their ability to perform financial accounting entries throughout this entire cycle. The interactive program assisted them by performing arithmetic, displaying for them the up-to-date status of the "books", and by tutoring whenever a mistake was made. (In this last "tutor" mode, the program indicates each entry which is made in error - pointing to the exact part of the entry in error. In addition, it provides "hints" to the student to enable him to derive the correct answer, but only if the student asks for "help". Many other similar features of the program provide it with an ability to reasonably replicate the actions of a human tutor.)

The most important point about the program, however, is that it enables a student to thoroughly test his ability to actually perform all of the accounting functions which he has learned in one relatively short session at the computer console. In this way the student can check his detail and overall understanding of the material in a short session with the computer. The student can test and retest his knowledge by himself, at the time of his own choosing, with or without tutoring assistance.

The material included in the original version of CLOSE was simple for the best students - but of greater challenge to the less well prepared students to whom it is most particularly addressed. A version with advanced subject material has been prepared.

#### Process objectives for the experiment

The experimental course was designed with five "process" objectives clearly in mind. These were:

- (1) To improve academic productivity by making optimum use of the strengths of all of the resources available to the learning (not teaching) process.



- (2) To increase student satisfaction with the learning process by allowing pupils greater flexibility in the use of their time and greater initiative in the learning process through the above methodology.
- (3) To increase the quality of the learning process by providing, for those students who desired it in the particular subject, more meaningful access to the professor. (It is felt that not all students want, or can handle, great depth in all courses - but greater depth and breadth should be available to those who desire it in any particular course.)
- (4) To allow (and encourage) the students to feel a greater responsibility for their own education by putting the emphasis, through "self-study" and optional learning "feedback" mechanisms on "active" learning on the part of the student rather than passive classroom-based absorption of material.
- (5) To thoroughly test the validity of the innovative course by both quantitative and qualitative means. Measures of success were therefore designed and control sections run so that sound experimental results could be derived.

### III. Results of experimentation with the program

The course was run for the first time in the Fall term of 1971. There were seven sections of the course. Four sections were taught in the "regular" fashion - a combination of lecture and class discussion. Three of the sections utilized the innovative program (hereinafter these sections are referred to as self-study or "SS", with regular sections sometimes referred to as "REG").

Students selected particular sections in accordance with their schedules. Notification of which sections would be self-study was not given ahead of time.



In addition, every attempt was made to play down the "experimental" nature of the course. Although there is undoubtedly some Hawthorne effect in every innovation, it is felt that there was as little as possible involved in the experimental results.

In order to check the value of the program in an objective quantitative manner, the three self-study sections and the four regular sections were given the same mid-term and final examinations. In addition, a questionnaire was distributed to all students in both the self-study and regular sections at the end of the course to determine their subjective feelings about the course.

Results, both in terms of relative performance of SS versus REG sections on the examinations and in terms of student "feelings" about the course as noted on the 70-question questionnaire, suggest that the objectives-material-methods-resource matching approach to the course was a definite success. The results were as follows:

Objective evidence from examination results: All students in the course, both REG and SS, took the same two examinations (midterm and final) at the same time. The results were as shown in Figure 1.

The objective evidence from the examinations, both midterm and final, is clear. The self-study sections outperformed the regular sections. There is no reason to suspect that the two groups were not homogeneous in mental ability and background at the start of the course. Teaching ability undoubtedly makes some unmeasurable differences, but the average number of years of teaching experience in this course of the instructors for both SS and REG sections was approximately the same.\*

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\*Still, one suspects that the teaching factor may have played a definite role since significant differences in results caused by learning method alone are almost impossible to find in the literature. See (15),(16).





Mid-Term

	Regular Sections		Self-Study Sections	
Undergraduate	Mean	42.27	Mean	52.02
	Std. Dev.	9.62	Std. Dev.	11.28
	N	(67)	N	(23)
Graduate	Mean	51.54	Mean	52.09
	Std. Dev.	8.84	Std. Dev.	10.56
	N	(60)	N	(82)
TOTAL	Mean	46.65	Mean	52.08
	Std. Dev.	10.22	Std. Dev.	10.67
	N	(127)	N	(105)

Final

	Regular Sections		Self-Study Sections	
Undergraduate	Mean	87.66	Mean	101.55
	Std. Dev.	19.48	Std. Dev.	21.36
	N	(57)	N	(21)
Graduate	Mean	102.17	Mean	105.10
	Std. Dev.	20.1	Std. Dev.	25.45
	N	(57)	N	(82)
TOTAL	Mean	94.91	Mean	104.37
	Std. Dev.	21.02	Std. Dev.	24.61
	N	(114)	N	(103)

Figure 1



The differences for the TOTAL (both undergraduate and graduate) scores of SS versus regular (52.08 vs. 46.65 on the midterm and 104.37 vs. 94.91 on the final) is highly significant at the .01 level on a t-test. On both examinations, SS undergraduates and graduates outperformed their REG counterparts. But the difference is most striking with regard to undergraduates. However, when a group of graduates who took the course in a "regular" section as an elective (and who therefore might be expected to be more motivated toward the material) is removed from the data, the examination results show a significant difference in the graduate ranks in favor of self-study, also!

Subjective evidence from questionnaires: In the free-form section of the course questionnaire, self-study students provided some logic behind the above results. Some of the ideas frequently expressed were:

"I felt the responsibility for learning the material had been transferred, under self-study, from the professor to me."

"Self-study is a lot more productive. I didn't have to waste time in class on things I already understood...or spend time in class when I was too far behind for the class to do me any good."

"The computer program enabled me to check on my own learning of the entire first half of the course when I was ready to do so. That's great. You ought to have a program for the second half, too, if you can design one. It helps to be able to review all the material - for integrated understanding - in 2-3 hours on the computer."

The instructors liked it, too. One self-study instructor summarized his views by saying:

"I've never enjoyed teaching so much. I taught only those things which require a professor. Self-study removed the 'transmission' of a lot of the dreary details which can be learned from a book. The question sessions, above all, were challenging and fun. Only those students who were motivated to come showed up - and our discussions were always lively".

"We got to discuss, in addition to the strict course material, things like management in general, and philosophies of life - both mine and theirs. These were things one would hesitate to tie up a class of 40 on - but with 10-12 interested students, these discussions came naturally."



"The variety of possible questions, some of which I could not answer (students could ask anything) somehow made me appear more human, I think... a bit less the 'authority' and a bit more an 'assistor in the learning process.' This is the only way to teach. The students who want personal contact get more attention than they would otherwise get (10 people in question sessions vs. 40). Those who are satisfied merely with picking up the basic knowledge alone in this particular course are left alone to do so most easily and efficiently."

More quantitative assessments of these "feelings" are available from the course questionnaire data. Student answers to eight of the questions tell much of the story.\*

As can be seen from the data in Figure 2, the students in the self-study sections heavily favored self-study as a method of learning the material (question 1). Interestingly, the students in the regular sections - many of whom had seen the SS materials or talked with their classmates about it - also favored self-study. Some 8% of SS students did not favor SS - which says, at least, that learning styles differ.

This particular course has always been seen as valuable by students. It maintained this ranking with students this term, but was especially favored by self-study students (Figure 2, question 2).

Since the course is aimed primarily at transmitting "techniques" and "principles", it is rewarding to note that self-study and regular students perceive the course as performing this task (questions 3, 4). Self-study students perceived a greater change in their knowledge of management principles and techniques. Interestingly, however, although it might be expected that the study-by-yourself mode would lead only to knowledge of "facts", self-study students (with a minimum of classes) also clearly felt that they were more stimulated to think about the "issues" than did students in the regular sections (question 5)! It is hypothesized that the available classroom time is more intensively utilized to focus on important issues by both professor and students.

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\*Seven point scales were used. For clearer exposition, and to allow Chi Square analysis, the points were grouped to a three point scale.



"For learning the material in this course, self-study is a preferable mode."

	Strongly Agree	Uncertain	Strongly Disagree
SS	71	21	8
REG	41	42	17

Chi Square  
Significance Level  
.005

"This course will be more useful to me in the future--compared with other courses."

	Strongly Agree	Uncertain	Strongly Disagree
SS	50	40	10
REG	35	49	16

Chi Square  
Significance Level  
NS

"During the course my knowledge of management techniques changed considerably."

	Strongly Agree	Uncertain	Strongly Disagree
SS	70	28	2
REG	49	46	5

Chi Square  
Significance Level  
NS

"During the course my knowledge of management principles changed considerably."

	Strongly Agree	Uncertain	Strongly Disagree
SS	59	35	6
REG	49	45	6

Chi Square  
Significance Level  
NS

"In this course, the professor stimulates students to think about the issues."

	Strongly Agree	Uncertain	Strongly Disagree
SS	46	51	3
REG	19	56	25

Chi Square  
Significance Level  
.005

"Professor has a clear plan for the semester's work."

	No	Uncertain	Yes
SS	4	16	80
REG	25	42	33

Chi Square  
Significance Level  
.005

"Class sessions are always interesting."

	No	Uncertain	Yes
SS	25	50	25
REG	49	49	2

Chi Square  
Significance Level  
.005

"Professor motivates student interest in the material."

	No	Uncertain	Yes
SS	7	44	48
REG	46	49	5

Chi Square  
Significance Level  
.005

Figure 2

# SIGNIFICANT QUESTIONNAIRE RESULTS

(A pertinent set of 9 of the 70 questions)





9. "Professor is available  
for outside assistance."

	No	Uncertain	Yes
SS	13	34	53
REG	28	57	15



Finally, it was clear that the self-study mode forces the professor to invest more heavily in thinking through the course, planning it carefully, and having a clear idea as to the goals and subgoals of the course. This effect was evident to the students as shown by responses to questions 6-8 in Figure 2.

The course design and the materials for implementation purposes required approximately four man-months of effort. As noted below, the resulting increase in academic production can quickly ammortize this investment.\*

#### Relationship to academic productivity

The course allows a 50% increase in academic productivity. One instructor can now handle three sections instead of two. This potential gain will be implemented in the Fall 1972 term - the next time the course is taught.

This statement concerning productivity is based on the conclusion that the average number of students in each question session can be increased from 10 to 15 with little effect. Thus one instructor can "lecture" three sections and combine them into two for "question session" purposes - providing an exactly equivalent teaching hour load for the instructor as in the past with a 50% increase in sections taught. Briefly:

<u>Old System (2 sections)</u>		<u>New System (3 sections)</u>	
Sections	= 2	<u>Lecture</u> sections	= 3
Class sessions	= 24	Lecture class sessions	= 8
Hours per session	= 1.5	Hours per session	= 1.5
(2 x 24 x 1.5)	= 72 class hours	(3 x 8 x 1.5)	36 hours

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\*In addition, some course redesign takes place each year. Therefore, the four months of curriculum development effort is not all "extra" effort.



Question sections	= 2
(At 15 students per session average)	= 12
Question sessions	= 12
Hours per session	= 1.5
(2 x 12 x 1.5)	= 36 hours
TOTAL LOAD (36 + 36)	72 hours

During this term there was evidence that the increase in students in the question sessions from an average of 10 to 15 was highly feasible. A very few sessions, did, in fact, have 15 students. These sessions were felt in no way to be inferior.

#### Relationship to educational quality

It is felt that this course has increased the quality of education in several ways. First, students in the question sessions had a chance to follow their agenda. They could inquire about what interested them - whether or not it was part of the strict curriculum. And the students took advantage of it. Questionnaire data reflect their belief that the course was better planned and better orchestrated for them. Second, and perhaps most important, the individual students who most wanted exposure to the instructor in this particular course received it in the self-study group. Twenty-five per cent of the class, on the average, attended the "question" sessions and received attention as if the 40 man class were a 10 man seminar! In the questionnaire, "access to the instructor" was seen to be significantly greater (.001 level) in the self-study sections than in the regular sections (Exhibit 2, #9). Some students noted that the computer program allowed them to get an integrated understanding of that section of the material which they felt was not available in previous courses they had taken.



This particular course deals with basic material. Its decreased need for faculty time will also provide faculty availability to teach more professor-dependent material in later courses in smaller sections. Alternatively, greater faculty time will be available for curriculum development to introduce new concepts and material.

#### SUMMARY

The educational literature has recorded many advances in technique over the past few years. Some have stressed technology. Others have stressed more awareness of human potential and psychology in the learning process. Unfortunately, most of these advances have been applied one at a time.

This paper suggests that the strengths of each of the three major available resources in the learning process must be clearly understood and the use of these three resources carefully orchestrated in each course. The exact use of each resource will depend on previously defined course objectives, the transformation of these objectives into relevant classes of material, and the methods which are chosen to best transmit each type of material. We know a great deal about this process, but it is far from a science at present.

An illustration of the recommended process as performed for a particular course has been given. It suggested that careful use of the process, resulting in an integrated and selective use of the available resources, can result in greater academic productivity, while at the same time increasing both perceived course quality and student satisfaction with the course.

Of some importance is the fact that this educational change is implementable in today's universities. It is not a radical departure, yet it goes far toward meeting some of the currently felt needs in education as noted in the first several paragraphs of this paper.\*

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\*See Schein (17) for a discussion of the importance of this last factor - the need to fit educational innovation into the present system.





REFERENCES

1. Drucker, P.F. "The Surprising Seventies", Harper's Magazine, July 1971, p. 39.
2. Dearden, F. Essentials of Cost-Accounting, Addison-Wesley Publishing Company, Reading, Mass, 1969.
3. Nordman, B.J. "Teaching Machines and Programmed Instruction: An Introduction and Overview", Report No. 260, University of Illinois, 1962.
4. Grubb, R.E. "Learner-Controlled Statistics", Programmed Learning, January 1961, pp 38-42.
5. Wilkinson, J.W. Accounting with the Computer: A Practice Case, R.D. Irwin, Inc., Homewood, Illinois, 1969.
6. Zannettos, Z.S. et al. "The Developments of an Interactive Graphical Risk Analysis System", Working Papers 502-70, Sloan School of Management, Massachusetts Institute of Technology, 1970.
7. Keller, F.S. "Good-bye Teacher...", Journal of Applied Behavior Analysis, Vol. 1, #1, Spring 1968, pp 78-89.
8. Green, B.A. "A Self-paced course in Freshman Physics", Occasional Paper #2 of the Education Research Center, Massachusetts Institute of Technology, Cambridge, Mass., 4/24/69.
9. Ferster, C.D. "Individualized Instruction in a Large Introductory Psychology Course", unpublished manuscript, Georgetown University, 1968.
10. Scott-Morton, M.S. "On Educational Technology", unpublished paper, Sloan School of Management, Massachusetts Institute of Technology, 1970.
11. Schein, E.H. Professional Education: Some New Directions, McGraw Hill, New York, New York, 1972, pp 97-98.
12. Anthony, R.N. Management Accounting, Richard D. Irwin, Inc., Homewood, Illinois, 1970.
13. Horngren, C.T. Accounting for Management Control, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1970.
14. Gordon, M.J. and Shilling Law, G. Accounting: A Managerial Approach, Richard D. Irwin, Inc., Homewood, Illinois, 1964.
15. Guetzkow, H., Kelley, E.L. and McKeachie, W.J. "An Experimental Comparison of Recitation, Discussion and Tutorial methods in College Teaching", Journal of Educational Psychology, Vol. 45, #4, April 1954, pp 193-207.
16. Grayson, L.P. "Costs, Benefits, Effectiveness: Challenge to Educational Technology", Science, Vol. 175, March 17, 1972, p. 1219.
17. Schein, E.H., op. cit, p. 97.

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